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Status of individual follicular group harvesting

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Introduction

In the early 1990s I recall attempting to extract individual pilosebaceous units using a 1 mm trephine. The success rate was quite low so I, like many others, abandoned the effort and moved on to strip harvesting. Dr. Ray Woods, however, did not give up. He continued working on individual follicular group harvesting and by 2001 we began to hear of his success in multiple cases. He called his procedure the "Woods Technique." In early 2002 I began working on my own version of individual follicular group harvesting (IFGH) based on his success. The first attempts produced mixed results. By late 2002, however, I began working earnestly to develop my own technique for IFGH and began having increasing success. Since then I have noted progressive improvement as a function of time and instrumentation. I am not alone in this evolution. In 2002 there were very few procedures of IFGH, but by 2006, it comprised 7.4% of all hair transplant procedures.¹ It is becoming more popular with time.

Many physicians have created their own names for their IFGH, which presents a situation unlike any other condition with regard to donor harvesting. There are those who consider this marketing.² It may be for some, but I feel strongly that this procedure—unlike any other method of harvesting—requires individualization with regard to name because each result is so variable from one technique to another. When I first developed my techniques and instrumentation, I called it FIT (follicular isolation technique).³ As my procedure advanced, I termed the techniques and instruments CIT™ (Cole Isolation Technique), and my procedure today is completely different from the original proprietary procedure I developed between 2002 and 2003.

Furthermore, as you survey the list of physicians who offer this sort of donor harvesting, you find that very few annotate their transection rate, their calculated density, or the percentage of their practice devoted to IFGH. Those who do note their transection rate are few and their rates are generally high or involve only a small sample of patients. In addition, their methods of harvesting vary. As such the variety of practitioners involved in this method of donor harvesting seem to all have slightly different techniques, results, and instruments. Similarly, individual results and efficiency are highly variable. Thus, individual names are essential. This is not a simple procedure that you teach yourself in one week or learn in a 1- or 2-day course. It is a procedure that requires dedication, devotion, enthusiasm, skill, and appropriate instrumentation along with technique. I have been revealing my transection rate, my calculated density, and the percentage of my practice devoted to CIT since I first presented the data in Florence, Italy, in 2004.³ Our mean transection rate in 2003 was 8% and our calculated density was 2.49 hairs per graft. I define transection as more than 10% of the upper part of a follicle and any portion of the lower part of the follicle. Determination of the transection rate was determined by totaling all the hairs in all the grafts. Then the total number of transected hairs was divided by the total number of hairs to determine the transection rate. Since 2004 I have presented my transection rates, etc., at

annual meetings and in small Internet chat groups involving numerous well-respected physicians. Gradually, as my instruments improved, the transection declined and the calculated density increased. The calculated density was determined by dividing the total number of hairs by the total number of grafts. The calculated density defined the mean number of hairs per graft. By 2006 our transection rate was 2.57% and our calculated density was 2.93 hairs per graft, and it has continued to evolve.⁴ CIT comprised 90% of my practice from 2003-2007. It is now 98% of my practice.

The general waste basket term for IFGH is FUE. This term is inherently flawed, as is the term follicular unit for the grafts we produce during hair transplant surgery. In 1995 Drs. Rassman and Bernstein labeled our grafts follicular units that contain 1-4 terminal hairs by borrowing the term from Dr. John T. Headington.⁵ Headington defined the follicular unit as the pilosebaceous unit as disclosed at the mid-dermal level under H&E taken from the crown of cadavers.⁶ He was not describing a gross anatomical structure. He was describing a histological structure. He stated that the follicular unit consisted of between 1-4 terminal hairs and 1-2 vellus hairs. As follicular groups on the surface of the skin are often comprised of more than 4 terminal hairs, Rassman and Bernstein are by definition incorrect. In a 2007 article published by Rassman, Bernstein, and Limmer, they acknowledged that occasionally the follicular unit has 5 hairs in complete contradiction to Rassman and Bernstein's original re-definition of the follicular unit published in 1995 and to the father of the term, John Headington.^{2,5,6} They went on to state that a group of physician lexicographers defined the follicular unit in an attempt to bring guidelines to our field.² Multiple wrongs hardly make a right. I pointed this out in a 1999 article published in the *Hair Transplant Forum*.⁷ Bernstein takes free liberty at modifying others' terms so I was not surprised when I saw that he attempted to redefine FIT, a term that Rose and I popularized.

The term FUE took hold immediately in 2002 with the paper published by Rassman and Bernstein describing their own method for IFGH.⁸ The original paper on FUE explained that Rassman and Bernstein had worked to develop their procedure since 1997. Five years later they described five categories of patients: Fox 1 through Fox 5. They stated that patients needed to undergo a Fox test to determine if they were candidates for the procedure. This study involved 200 patients. They noted that 26.5% were Fox 1, which meant that most of the follicles were extracted intact. The remaining 73.5% were Fox 2-5. Fox 2 patients had follicular transection rates up to 20% and Fox 3-5 had progressively higher transection rates, but their definition otherwise lacked objective criteria. Thus, it would be my opinion that only Fox 1 patients were candidates for FUE. They considered Fox 1 and 2 candidates for the procedure, but with a transection rate of 20% for Fox 2 patients, one might hardly consider this group a candidate for the IFGH. In other words only 25% of the patients were ideal candidates for IFGH.

Since 2002 has the efficiency changed for the majority of physicians performing FUE today? Yamamoto described

patients as easy, difficult, and dangerous in a 100-patient study using a one-step mechanical method of FUE.⁹ In his study, only 25% of patients were easy with transection rates up between 0-30% based on his predictive CTGR scale (completely transected graft rate). The remaining 75% of patients had transection rates over 30% based on his CTGR scale. To his credit he recommended that physicians recognize that more than one technique is often required to make all patients successful candidates. Nagai reported that his scalp transection rates were usually less than 20%, but noted a transection rate of 55-74% with body hair.¹⁰ Harris only recently reported that his SAFE system produced a range of 0-8% transection in a study involving only 40 patients, but failed to note the mean transection rate.¹¹ This is very little data given 3 years of promotion and sales for the SAFE system and would lead you to suspect the mean transection rate was closer to 8%, which is why it was not reported. Yamamoto noted recently that his two-step method using a serrated punch similar to Harris produced a transection rate of 9.5% in one patient.⁹ Furthermore, Harris seemed to give up this year when asked to debate the value of FUE and chose rather to discuss the virtues of strip surgery over FUE at the 2008 ISHRS conference in Montréal.¹²

My own definition for FUE is that it is a method of follicular extermination because the transection rate is so high. Therefore, I find it inappropriate for anyone to categorize my procedure under the wastebasket term, FUE. Given such limited data and dismal transection rates, I feel compelled to discuss my experience with IFGH and offer some advice.

Such limited data and elevated transection rates have fostered the many misconceptions about IFGH. Many feel the procedure is always difficult to accomplish and results in a poor yield. Many physicians feel it takes too much of their time. They prefer to allow the surgery techs to dissect the grafts following a very simple removal of the strip from the donor area and closure by suturing. Others feel the procedure distorts the follicular groups in the donor area such that it is not possible to safely harvest follicles in a subsequent procedure. Many feel you cannot match the yield of a strip harvest. Some feel the procedure is inherently flawed. Many feel that the trichophytic donor closure produces an aesthetically suitable result that obviates the rationale for individual follicular group harvesting.

Objective

The purpose of this discussion is to address these misconceptions by simply stating our results using CIT to harvest individual follicular groups. Since 2002 we have accumulated a considerable amount of data detailing the progressive success of our procedure. Along the way I have noted that it is possible to perform large procedures with speed, accuracy, and a high yield. We have not found any evidence that our procedure produces distortion of the follicular groups. In other words, subsequent procedures have the same success rate as the initial procedure.

Material and Methods

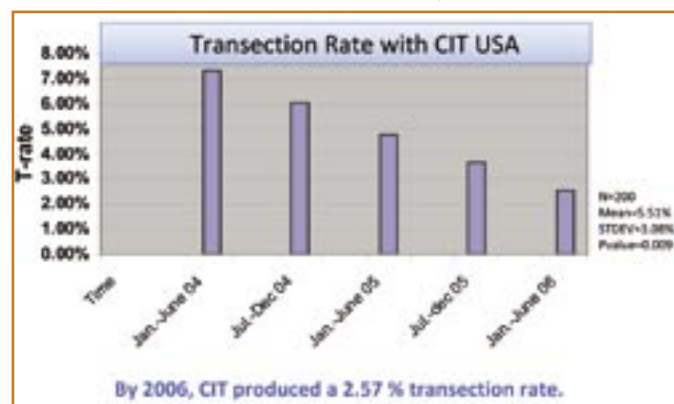
The following is a study of 200 patients we presented in 2006 documenting my average number of hairs per graft (calculated density) and the transection rate from 2004-2006.⁴ We have manual and mechanical methods of extraction. As every donor area is different, we have over 38 options

that we can adjust in an infinite number of ways to make the procedure work on all types of donor areas. The instruments for extractions are sharp, not blunt, instruments. The rate of extraction for us ranges from 500 per hour to over 1,300 per hour.

Results and Discussion

Transection rates. The mean transection rate from 2004-2006 was 5.51%, but by 2006 it was only 2.57% (Table 1).⁴ It remains under 3% today. Our methods and instruments for individual follicular group extraction with CIT produce much lower transection rates than have been previously been reported in the literature. With regard to transection rates for strip dissection there have been comparatively few studies. Both Cole and Pathomvanich found that the transection rate for single-blade elliptical harvest produces a transection rate of less than 2%.^{17,30} Pathomvanich found in 50 patients that the mean transection rate with strip harvesting was 1.97%. He further found that the transection rate for micro- and mini-graft production from the strip was 1.21%. The combined mean rate was 3.18%. Limmer found a range of 0-5% with graft elliptical strip graft dissection, but it was usually 2-4%.¹⁹ I find his results spurious as it was impossible to remove a strip with a 0% transection rate at the time his study was performed. Limmer found 8-15% with three strips 3mm wide.²⁰ Cooley had 12 physicians send him tissue. He

Table 1. Transection Rate with CIT, USA



found that microscopic dissection yielded 10.2% transection while loupe dissection had a transection rate of 20%.²¹ Reed found a 16% transection rate from excision with a multi-handle blade and 6% with his most experienced technician with elliptical excision and microscopic dissection (EEMD).²² There are inherent flaws with determining transection rates with strip surgery. You are removing several thousand hairs at once with a strip. An accurate transection rate depends on an accurate hair count in the strip. As an example, Devroye and I counted all the hairs in slivers taken from a multiblade handle taken by another physician that produced considerable transection while visiting Sandoval's Mexico meeting in 2000. We counted 2085 hairs, but when the technicians were asked to count the hairs in the grafts they produced from the strip, they annotated only 1,398 hairs (33% less than was in the slivers). The technicians stated they had not counted the transected hairs. Certainly two possibilities exist: They either failed to count all the hairs or they ignored the transected hairs and discarded them. In comparison, my mean CIT transection rate is lower than mean strip harvesting transection rates published to date. There is one advantage to

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transection with IFGH in general. The transected follicles are either left in the donor area or reimplanted. Studies including Kim, Mayer, Limmer, Swinehart, Martinick, Reed, and Hwang have shown that transected follicles have the capacity to regrow, though the percentage may be as low as 30% and the diameter may be reduced.^{23,24}

Hair growth. I evaluated hair growth by transplanting two boxes of 0.81 cm² with grafts. Box one had 26 grafts and box two had 23 grafts. Box one had 20 grafts growing hair at 3 months while box two had 18 grafts growing hair at 12 weeks for a respective yield of 77% and 78%. At 16 weeks the graft yield was 88% and 95%, respectively. In other words, the yield for CIT at 16 weeks is comparable to many strip surgery yield studies.

Calculated density. How does our calculated density (the average number of hairs in the grafts) compare to previous revelations about the calculated density seen in strip surgery? Previous calculated densities from strip surgery reported by Dr. Bernstein were 2.28 for microscopic dissection and 2.14 for loupe dissection.¹⁴ In 1998 Cole presented a mean calculated density based on densitometry using the Rassman densitometer in 40 patients of 2.34.¹⁵ In 1998 Cole revealed data showing a mean calculated density of 2.10 in a 121 patient study that evaluated 29,626 microscopically dissected grafts.¹⁵ In 1999 Cole presented a study at the OLSW comparing loupe dissection to microscope dissection in the same patient using contra-lateral same regions of the donor area for comparison.¹⁶ The study consisted of 43 patients. The calculated density for microscope dissection was 2.02, while the calculated density with 5 × loupe dissection was 2.05. In yet another study involving over 105,000 microscope and loupe dissected grafts Cole found that strip dissection produces a mean of 2.0 hairs per graft.¹⁷ We presented our CIT calculated density from 2004-2006 at the 2006 ISHRS meeting in San Diego. The results are summarized below and show that CIT has consistently produced a higher calculated density than strip surgery over time (Table 2).

CIT produces a higher calculated density because intact follicular groups are removed by cherry picking the grafts with the greatest number of hairs. CIT produces a higher calculated density than strip surgery for two reasons. First, strips consist of follicular groups of multiple sizes; some clusters are small and some large. With a strip you get all the groups of all sizes. It is more similar to taking all the fish

in a barrel, while with CIT you can remove only the largest fish. With CIT you cherry-pick the groups with more hair. Second, the technician dissects the strip and often splits larger follicular groups into multiple smaller groups. I term this practice fractionation of the follicular group, and Martinick has shown that such a practice can reduce the yield with 3-hair follicular groups.²⁵

CIT in Asian patients. Is CIT reproducible? CIT is now in Europe and in Korea. In Europe the transection rate and the calculated density are parallel to mine. In Asia the first month of surgery resulted in a transection rate of 4.66% and the calculated density of 2.8 hairs per graft. By the second month Asia had a mean transection rate of 4.3% and a mean calculated density of 2.77 hairs per graft. The overall range since introduction of CIT to Asia was 0-10.96%. Asians are generally regarded as having fewer hairs per graft, yet with CIT they are obtaining a significant increase in hairs per graft. The following have been reported thus far in Asia. In Korea the average number of hairs per graft was reported based on age ranging from 1.62-1.91 by the Korean Dermatology Society.²⁶ Imagawa recently reported that 80% of Asian grafts consist of 1 or 2 hairs.²⁷ This correlates roughly to a calculated density of 1.9 based on his report that Asians have 50-64% 2-hair grafts and 13-17% 3-hair grafts.²⁸ Pathomvanich reported that his patients average 1.8 hairs per follicular unit.²⁹ Pathomvanich reported that a sample of 30 patients undergoing strip harvesting had the following distribution of follicular groupings: 23.65% 1-hair FG, 63.83% 2-hair FG, 12.52% 3-hair FG, and 0-1% 4-hair FG.²⁹ With CIT in Korea we find the following distribution of follicular groupings: 1.5% 1-hair FG, 34% 2-hair FG, 55% 3-hair FG, 9.3% 4-hair FG, and 0.4% 5-hair FG. In other words, patients in Korea are receiving more hair from an equal number of grafts with CIT and a much better value than those patients who are having a strip procedure. Korean CIT and Asian strip follicular group distribution is summarized in Table 3.

Table 3. Asian Calculated Density



Appearance of the donor area. There is no such thing as an immaculate procedure. All methods of donor harvesting leave confirmation that surgery occurred. There are simply different degrees of evidence. Individual follicular group harvesting produces varying degrees of evidence based on individual patient healing characteristics and the number of follicular groups that are harvested. The best way to minimize this evidence is to spread the extractions out over a larger area so that the reduced density is equally dispersed throughout the donor area. With larger procedures evidence of donor harvesting becomes more obvious when the head is shaved, but with the hair length at 1 cm or more, the evidence becomes far less noticeable and therefore even very large

Table 2. CIT Calculated Density, USA



sessions of IFGH carry substantially less risk than large strip surgeries (Figures 1 through 4).

One can rationalize why IFGH carries less risk by noting that IFGH is simply the reverse of follicular group transplanting to the bald area. Rather than adding one follicular group at a time, one is simply removing one follicular group at a time. The greatest risk is that the extraction sites will become hypopigmented when they heal. This complication is called "white spotting." I have found that I can minimize this by relocating body hair to the extraction sites, a procedure I call "donor area farming." The body hair grafts carry melanin and the hair regrowth results in re-establishment of the blood supply to the follicle and its surrounding tissue. The combination of circulation and dermal pigment significantly reduces the risk and the appearance of white spotting. There are those who have minimal risk of white spotting; generally these individuals have less skin pigment to begin with, such as a Fitzpatrick type I or II. It is interesting that African Americans almost always heal without hypopigmentation or hyperpigmentation. The extremes of the Fitzpatrick types seem to exhibit the most ideal healing. Punch size seems to have no affect on the degree of hypopigmentation provided the entire follicular group is extracted, which lends greater support to the hypothesis that white spotting is due to a loss of melanin and circulation required by the follicular group. It is also worth noting that white spotting rarely occurs on the back, beard, and lower extremities, while it is quite common on the chest and abdomen. Perhaps there is a greater propensity for melanin migration in some skin regions.

Conclusion

In summary, CIT produces a lower transection rate and a greater calculated density than strip surgery and microscopic dissection. CIT also shows that a much lower transection



Figure 1. Fitzpatrick 2 following removal of 5,135 grafts.



Figure 2. Fitzpatrick 4 of Mediterranean descent following removal of 5,700 grafts. White spotting becomes more evident in this skin type.



Figure 3. Korean donor area after removal of 2,000 grafts.



Figure 4. Korean donor area with the hair cut short following removal of 2,000 grafts.

rate is possible than with FUE. Physicians are encouraged to pursue their own methods of individual follicular group removal because lower transection rates are possible than has been previously reported with FUE. In addition, a higher calculated density may be achieved. Finally, we have shown that excellent yields comparable with strip surgery are possible with CIT, which should provide additional encouragement to those currently pursuing IFGH in their clinics. CIT is reproducible in multiple countries including Asia. In all regions and with all hair types, CIT produces a higher calculated density and a very comparable transection rate when compared to strip surgery.

How can you improve your results? First, you must believe it is possible. Hopefully, this excerpt of my experience will give you the motivation. Second, you must realize that no two donor areas were created the same. You must be able to adapt and try different tools or techniques. Experience has taught me what to do and when to do it. Anyone can do this provided they have the resolve to pursue it and the creativity to produce the necessary instrumentation. Third, you must have the meticulous hand-eye coordination to carry out sub-1mm precision tasks. Finally, you must have the patience and perseverance to overcome the many potential obstacles. Provided you have all of these, you will be successful. Stop listening to those who say it is not possible and find a way. Scientists must not live like frogs in a well where their only reality is their immediate surroundings and a little patch of blue sky. It is time for more physicians to recognize that this is a procedure you can do with even better results than with strip surgery.

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Editors' Note: The author was asked to further expand on the instruments he uses and how this CIT procedure could be learned by other colleagues interested in it. Dr. Cole's response was that he uses all sharp punches but that the geometries, types of metal, edges, and angles are proprietary trade secrets that took years to develop. Dr. Cole currently licenses the procedure for a fee.

The editors are not in favor of accepting for publication manuscripts that do not openly describe the technical procedure, tools, etc. We are conscious of the fact that this paper would have not been accepted in any peer review journal without revealing those techniques or tools. However, given that the topic of FUE itself is still a highly controversial issue with very little published data regarding transection rates, we have taken into account the author's intent to generate thought-provoking ideas. In addition, because readers are free to discuss and/or refute Dr. Cole's assertions using the *Forum* as their vehicle, we have decided to accept this manuscript. ✧